at the southern end of the Loroghi mountains. The intention was to go westward to search for another tribe from which to buy transport animals. Sayer was reached, and some guides belonging to a tribe designated by a name which is no name—Wanderobbo—were secured. The country was in famine, and the Wanderobbo were starving. They begged Chanler to kill them some food, and he and von Höhnel spent some days shooting elephant, during which the author had several extraordinary escapes. He was preparing to start westward, when von Höhnel was knocked over by a rhinoceros and seriously injured. He was carried back to Daitcho, and thence sent to the coast. From this time the story of the expedition is a catalogue of disasters. All the camels had long since been dead, and most of the repeated relays of donkeys had suffered the same fate. Galwin was sent back to Ukamba to buy more of the latter. The Tana rose in flood, and for months the two halves of the expedition were separated ; meanwhile the remaining donkeys were dying, and the rainy season, during which alone it was possible to cross the northern deserts, was being spent in enforced idleness. Then the Zanzibari suddenly mutinied and marched in a body to the coast. Soon after this the Soudanese, frightened by some preparations for the arrest of any Zanzibari who might be found, also bolted. The author had to destroy his stores, worth 9000 dollars, and return to the coast, which he reached at Mombasa after an absence of sixteen months.

The last pages of the volume contain the story of quarrels with the authorities at Zanzibar in regard to the treatment to be given to Chanler's deserters, who had been detained in Zanzibar. The author is very severe in his condemnations of the Zanzibar and British authorities. He declares that they suggested and instigated the mutiny, or at least gave the leader " something stronger than a hint " (p. 466) ; and on Mr. Chanler's return to Zanzibar, he was unable to obtain any assistance from them in securing the punishment of his men. The Prime Minister of Zanzibar, Sir Lloyd Matthews, held that the porters were justified in their desertion, and instead of punishing them, demanded from Mr. Chanler the full amount of pay due to them—a demand with which the author refused to comply. The question is an important one, but it is unnecessary to discuss it here. Mr. Chanler is naturally angry with the men whose desertion ruined his plans, and with the authorities who subsequently believed their story and took their part. Mr. Chanler admits that he has no very satisfactory theory of his men's desertion, which took him quite by surprise ; or why the Zanzibar authorities should have urged his headman, Hamidi, to organise the revolt. But no one who knows General Matthews, and his readiness to help the traveller of any nationality who applies to him, will credit the charges made against him.

It is a pleasure to turn from the sad story of foiled plans, wasted chances, and angry accusations, to consider the value of Mr. Chanler's work, which represents a substantial addition to our knowledge of British East African geography. The author's text and Lieut. von Höhnel's magnificent map (which unfortunately often differ greatly in the spelling of the place-names) are contributions to the knowledge of British territories for which English naturalists and administrators must be

grateful. Mr. Chanler has given us a map of an unknown region, discovered a most remarkable and interesting tribe, solved an important geographical problem, and made valuable scientific collections. He achieved these results by a generous expenditure of time and money, and at the cost of great personal hazard and hardship ; and if he did not carry out the whole of the ambitious scheme at which he aimed, he displayed magnificent perseverance and courage in trying time after time, by route after route, to traverse the barren desert before him.

We cannot, however, but regret that Mr. Chanler's journey involved considerable bloodshed, and that the spirit with which he regarded this, may be gauged by his remark (p. 329), " I could not permit myself to indulge in the pleasure of an attack," although " the temptation to yield [to the entreaties of his men to seize the rich herds of a tribe with whom he had contracted the rite of blood-brotherhood] was, I must admit, next to impossible."   J. W. GREGORY.

APOLLONIUS OF PERGA.

Apollonius of Perga: Treatise on Conic Sections. Edited in Modern Notation, with Introductions, including an Essay on the Earlier History of the Subject, by T. L. Heath, M.A. Pp. clxx + 254. (Cambridge : at the University Press, 1896).

THE assertion made in the opening lines of the preface to the book now before us, that " to the great majority of mathematicians at the present time, Apollonius is nothing more than a name and his " Conics," for all practical purposes, a book unknown," is probably well within the truth. That this should be so is a pity, because the work of the great geometer is not only valuable and interesting in itself, but affords an excellent example of the methods of Greek geometry at its best period.

Nevertheless it must be admitted that this state of things is not altogether surprising. To read through the " Conics," say in Halley's folio edition, requires not a little courage and perseverance. A modern geometrician, approaching the text for the first time, cannot fail to be struck, and is in most cases repelled, by the curious combination of crabbedness and diffuseness which it appears to present. On the one hand the nomenclature is really very concise, almost as much so, in fact, as the quasi-algebraical notation at present in vogue ; on the other, there is an elaborate array of general enunciation, particular enunciation, distinction of cases, construction analysis, synthesis, and conclusion—all in strict accordance with the logical scheme which had become orthodox long before Apollonius's time. Formal demonstrations are given of propositions which we should be apt to dismiss as intuitively evident, and a preference is shown for indirect methods of proof which, in some cases, almost amounts to perversity.

Besides this, the reader who wishes to appreciate the " Conics " has to overcome a real and serious difficulty arising from the peculiar form in which the argument is presented. The Greeks elaborated the methods of geometrical proportion and the application of areas until they possessed an engine which, in capable hands, is, up to a certain point, as effective as the methods of modern

analytical geometry. In fact, a considerable part of Apollonius's treatise is coordinate geometry pure and simple ; but it is expressed throughout in a strictly geometrical form. This is not without its advantages, both theoretical and practical: it avoids the thorny question of the continuity of numerical quantity, and it compels the reader to realise the meaning of every step that is taken. It is not unlikely that a well-trained Greek mathematician could follow the geometrical demonstrations as easily as the modern analyst can assimilate the corresponding algebraical proofs ; it is anything but easy for one who has been brought up on the system now current to familiarise himself with the methods and points of view which prevailed in the age of the Ptolemies.

Still the labour is well worth undertaking, and Mr. Heath's edition will do much to lighten it. It may be well to state at once that the book will not relieve the serious student of the duty of consulting the original text. The editor, after performing the laborious task of literally translating the whole treatise, decided, very wisely, we think, not to publish it in that form. Instead of this, he has recast it into a form similar to that employed in most text-books on geometrical conics ; he has occasionally condensed several propositions into one, made some slight rearrangements of order, and omitted, or merely given an abstract of, a certain number of propositions which are either of slight importance, or indirect proofs of converses by the usual *reductio ad absurdum*.

The result is that the English reader has before him the substance of Apollonius's great work, in a notation with which he is himself familiar, while at the same time he may, with a slight effort, read it back into the geometrical form of the original. In this sense it deserves to be called an edition, and is not a mere caricature tricked out with modern " improvements." Apart from the notation, the book really gives a trustworthy presentation of the contents and method of the original ; the amount of alteration which the actual text has undergone may be estimated by the literal transcripts of Book III. Prop. 54, and Book II. Prop. 50 (one case), which will be found on pp. lxxxix–xciv of the Introduction. Some may object that the condensation is excessive ; but we are inclined to think that this is not the case, when we consider the object which the editor had in view, namely to provide an edition " so entirely remodelled by the aid of accepted modern notation as to be thoroughly readable by any competent mathematician."

In this praiseworthy aim Mr. Heath has certainly succeeded, and it may be hoped that the " Conics " will now attract the attention which it undoubtedly deserves. The more the treatise is examined, the more evident become its power and comprehensiveness. Apollonius begins by considering any plane section of a circular cone, not necessarily right, and at once obtains a result equivalent to the equations of the parabola, ellipse and hyperbola in the forms

$$y^2 = px, \quad y^2 = px \pm \frac{p}{d}x^2$$

referred to a diameter and the tangent at one end of it ; p being the parameter, and d the corresponding diameter. It is to be observed that, in the first instance, Apollonius speaks of *the* diameter, namely the particular one

associated with the axial triangle of the cone. He then goes on to prove the existence of a conjugate diameter, and shows that any chord through the centre is bisected there ; then, after a discussion of tangents, comes a very remarkable section, in which the transition is made from the original diameter and the tangent at one end of it to any other diameter and corresponding tangent. Every one is more or less aware of the fact that Apollonius practically solved the problem of drawing normals to a conic from any point in its plane ; it is perhaps hardly so well known that he was acquainted with many of the focal properties of central conics, with the auxiliary circle, and with the harmonic properties of poles and polars. Oddly enough, the focus-directrix property of a conic does not appear, and was apparently unknown to Apollonius ; the directrix is never used or mentioned, and the foci of a central conic are obtained by a construction equivalent to $AS.SA^1 = CB^2$. For this reason, no doubt, the focus of a parabola is not used or mentioned. But, with this one exception, almost all the principal theorems of ordinary geometrical conics are to be found in this treatise, composed more than twenty-one centuries ago.

The text of Mr. Heath's edition is preceded by a very valuable introduction, in which will be found an excellent account of the earlier history of conic sections among the Greeks, followed by an instructive essay on the characteristics and methods of Apollonius. This, with the appendix on the terminology of Greek geometry, will be of great service to those who may feel attracted towards research in the history of mathematics ; a subject not interesting to many, but fascinating to the few who combine the instinct of an antiquarian with the necessary linguistic knowledge and mathematical ability.

One or two suggestions may perhaps be made in anticipation of another edition. A glossary of Greek technical terms, or at any rate an index of them, with references to the pages of the introduction where they are explained, would be a useful addition. The figures, on the whole, are clear, but some of them might be more accurately drawn ; and in some of the longer and more difficult propositions it is very inconvenient to have to turn back to look at a figure on a previous page.

G. B. M.

THE HARE, FROM THE FIELD TO THE TABLE.

Fur and Feather Series.—The Hare. Edited by A. E. T. Watson. 12mo. Pp. 263. Illustrated. (London : Longmans, Green, and Co., 1896.)

FROM the first it was evident that the beautifully illustrated volumes of the " Fur and Feather Series " would appeal more to the sportsman and the *bon-vivant* than to the naturalist. That this is the case with the present issue may be inferred from the fact that out of a total of 263 pages, only a paltry sixty-two are devoted to what the author calls the natural history of the hare. As a matter of fact, it is impossible to apply the term " natural history " to the subject of more than the first forty-eight pages ; the third chapter in Mr. Macpherson's